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☐ 1. **Outline for a theory of intelligence**
Albus, J.S.;
Systems, Man and Cybernetics, IEEE Transactions on
Volume 21, Issue 3, May-June 1991 Page(s):473 - 509
Digital Object Identifier 10.1109/21.97471
Summary: Intelligence is defined as that which produces successful behavior. Intelligence is ass result from natural selection. A model is proposed that integrates knowledge from research in bot natural and artificial systems. The model consists of a .....
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☐ 2. **Study on eye gaze estimation**
Jian-Gang Wang; Sung, E.;
Systems, Man, and Cybernetics, Part B, IEEE Transactions on
Volume 32, Issue 3, June 2002 Page(s):332 - 350
Digital Object Identifier 10.1109/TSMCB.2002.999809
Summary: There are two components to the human visual line-of-sight: pose of human head anc orientation of the eye within their sockets. We have investigated these two aspects but will concei on eye gaze estimation. We present a novel approach called.....
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☐ 3. **A Drowsiness and Point of Attention Monitoring System for Driver Vigilance**
Batista, J.;
Intelligent Transportation Systems Conference, 2007. ITSC 2007. IEEE
Sept. 30 2007-Oct. 3 2007 Page(s):702 - 708
Digital Object Identifier 10.1109/ITSC.2007.4357702
Summary: This paper presents a framework that combines a robust facial features location with ; elliptical face modelling to measure driver's vigilance level. The proposed solution deals with the computation of eyelid movement parameters and head (face) poin.....
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☐ 4. **Models for the Design of a Tendon Driven Robot Eye**
Cannata, G.; Maggiali, M.;
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10-14 April 2007 Page(s):2916 - 2921
Digital Object Identifier 10.1109/ROBOT.2007.363914
Summary: Eye motion strategies in animals and humans have the goal of optimizing visual perce therefore, the study of eye motions plays an important role in the design of humanoid robot eye s Saccades and smooth pursuit in humans and primates are.....

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4-6 Dec. 2006 Page(s):151 - 156
Digital Object Identifier 10.1109/ICHR.2006.321377
Summary: Eye movements have the goal of optimizing visual perception, therefore the investigat eye motion strategies play an important role in the design of humanoid robot eye systems. Sacca humans and primates is a significant class of ocular mot.....
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6. **Implementation of Listing's Law for a Tendon Driven Robot Eye**
Cannata, G.; Maggiali, M.;
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Oct. 2006 Page(s):3940 - 3945
Digital Object Identifier 10.1109/IROS.2006.281828
Summary: This paper presents a model for a tendon driven robot eye designed to emulate the ac saccadic and smooth pursuit movements performed by human eyes. Physiological saccadic moti obey the so called Listing's law which constrains the admissible ey.....
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7. **Multimodal Face Detection, Head Orientation and Eye Gaze Tracking**
Wallhoff, F.; Ablabmeier, M.; Rigoll, G.;
Multisensor Fusion and Integration for Intelligent Systems, 2006 IEEE International Conference o
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8. **Photorealistic Attention-Based Gaze Animation**
Itti, L.; Dhavale, N.; Pighin, F.;
Multimedia and Expo, 2006 IEEE International Conference on
July 2006 Page(s):521 - 524
Digital Object Identifier 10.1109/ICME.2006.262440
Summary: We apply a neurobiological model of visual attention and gaze control to the automati animation of a photorealistic virtual human head. The attention model simulates biological visual processing along the occipito-parietal pathway of the primate bra.....
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Bretzner, L.; Krantz, M.;
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14-16 Oct. 2005 Page(s):161 - 164
Digital Object Identifier 10.1109/ICVES.2005.1563634
Summary: Recent studies show that driver fatigue and inattention are major causes of fatal road accidents. A large number of these accidents could be avoided if the vehicles were equipped with sensors that reliably could monitor the attention and alertness.....
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Biamino, D.; Cannata, G.; Maggiali, M.; Piazza, A.;
Humanoid Robots, 2005 5th IEEE-RAS International Conference on
5-7 Dec. 2005 Page(s):62 - 67
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Summary: This paper presents a new tendon driven robotic eye. The system has been designed emulate the actual saccadic and smooth pursuit movements performed by human eyes. The syst consists of a sphere (the eye-ball), actuated by four independent tendon.....
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11. **Improved Likelihood Function in Particle-based IR Eye Tracking**
Witzner Hansen, D.; Satria, R.; Sorensen, J.; Hammoud, R.;
Computer Vision and Pattern Recognition, 2005 IEEE Computer Society Conference on
Volume 3, 20-26 June 2005 Page(s):5 - 5
Digital Object Identifier 10.1109/CVPR.2005.474
Summary: In this paper we propose a log likelihood-ratio function of foreground and background used in a particle filter to track the eye region in dark-bright pupil image sequences. This model fu information from both dark and bright pupil images a.....
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Viollet, S.; Franceschini, N.;
Robotics and Automation, 2004. Proceedings. ICRA '04. 2004 IEEE International Conference on
Volume 1, 2004 Page(s):504 - 510 Vol.1
Digital Object Identifier 10.1109/ROBOT.2004.1307199
Summary: For any sighted mobile creature, whether it be natural or artificial, stabilizing the visua system is a much more crucial issue than that of preventing a snapshot from being blurred by the unsteadiness of a human photographer. The more immune the ey.....
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Cakmakci, O.; Yonggang Ha; Rolland, J.P.;
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2-5 Nov. 2004 Page(s):16 - 25
Digital Object Identifier 10.1109/ISMAR.2004.2
Summary: We are proposing an optical see-through head-worn display that is capable of mutual occlusions. Mutual occlusion is an attribute of an augmented reality display where real objects ca occlude virtual objects and virtual objects can occlude real objec.....
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Summary: Research on humanoid robots has produced various uses for their body properties in communication. In particular, mutual relationships of body movements between a robot and a hu considered to be important for smooth and natural communication, a.....
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Virtual Reality, 2002. Proceedings. IEEE
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Summary: A head-mounted projective display (HMPD) consists of a pair of miniature projection l beam splitters and displays mounted on the helmet and retro-reflective sheeting materials placed strategically in the environment. This has recently been prop.....
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Haritaoglu, I.; Cozzi, A.; Koons, D.; Flickner, M.; Zotkin, D.; Duraiswami, R.; Yacoob, Y.;
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Allison, R.S.; Harris, L.R.; Jenkin, M.; Jasiobedzka, U.; Zacher, J.E.;
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Summary: To enhance presence, facilitate sensory motor performance, and avoid disorientation nausea, virtual-reality applications require the perception of a stable environment. End-end tracki latency (display lag) degrades this illusion of stability and.....
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Kijima, R.; Ojika, T.;
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Digital Object Identifier 10.1109/VRAIS.1997.583062
Summary: The construction of virtual worlds often requires the user to use various tools in differe environments to create several types of elements which have geometrical properties and behavic characteristics. Due to the inconveniences associated with .....
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Essa, I.; Basu, S.; Darrell, T.; Pentland, A.;
Computer Animation '96. Proceedings
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Digital Object Identifier 10.1109/CA.1996.540489
Summary: We describe tools that use measurements from video for the extraction of facial mode and animation parameters, head tracking, and real time interactive facial animation. These tools s common goals but rely on varying details of physical and g.....
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Virtual Reality Annual International Symposium, 1993., 1993 IEEE
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Digital Object Identifier 10.1109/VRAIS.1993.380772
Summary: The authors have developed "augmented reality" technology, consisting of a see-thro head-mounted display, a robust, accurate position/orientation sensor, and their supporting electrc and software. Their primary goal is to apply this technology.....
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Grosso, E.; Ballard, D.H.;
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Summary: The authors consider orienting, that is, establishing and maintaining a spatial relation between a motorized pair of cameras (the eye-head system) and a static or a moving object track time. Motivated by physiological evidence, they propose a .....
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Summary: We present SMILEtrade (Science and Math in an Immersive Learning Environment) a immersive game in which deaf and hearing children ages 5-10 learn math and science concepts a ASL (American Sign Language) terminology through interaction with animate.....
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Driver's Characteristics for Map Information Representation (North up Map/Heading up map) in Navigation Displays

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Abstract

This paper investigates driver's characteristics for two kinds of map information representation(North-up map and Heading-up map) of In-Vehicle Navigation System (IVNS). This investigation consists of field experiments and laboratory experiments. The driver's behavior was investigated by eye movement and subjective evaluation. The results implied that the driver's visibility was influenced by the cognitive characteristics of the driver and the map representation should adapt to driver's spatial orientation.

Introduction

In recent years, the number of cars with IVNS is increasing in Japan and the function of IVNS becomes diverse. Most of them show the current location of the car and the direction of the destination on the digital map. There are two kinds of display forms to show the map. One is the North-up form which keeps the north of the digital map up. Another is the Heading-up form which rotates the digital map to keep the direction of movement of car in upward form. It is considered that the two forms have different charactristics and driver's potential cognitive characteristics are important factors in the interaction between a driver and the form of representation. This study investigates the relationship between the driver's characteristics and the form of displaying the map(i.e. North-up and Heading-up) by means of eye movements, subjective evaluation and cognitive characteristics such as spatial orientation.

Spatial orientation

In the field of cognitive science, cognitive map is defined as the concept which is thought that human internal representations about their location and the direction of his movement are made structurally. Spatial orientation generally treats how human beings recognize the direction of their movement or their location in space"[1]. It contains the ability to understand a map, frame of reference(evironment needed in recognizing their location), the process which mental map changes based on environment, and so on. In order to investigate the spatial orientation, a method based on the analysis of map drawn by subjects is developed. Angyal[2] and Sato[3] reported several results by using this method. One of the interesting results is that people can be categorized into two groups by the difference in recognizing spatial objects.

This paper describes human-system interaction based on the concept of spatial orientation and the characteristics of this result.

Eye movements

Generally speaking, more than 90 percent of the information needed for driving depend on the driver's visibility. Most of the traffic accidents are caused from the errors of visible recognitions or perceptive judgements. The CRT display were used as the way to express the route information in IVNS and it is important to decrease the visibility load when using IVNS. The capacity for driving is thought to increase by decreasing the fixation time to the navigation display.

Subjective evaluation

It is difficult to decide the items to evaluate IVNS subjectively. It isn't clear what aspects are good in the interaction between a driver and IVNS. In this study, the items of the evaluation are made from the results of verbal protocol analysis in the field experiments and in the laboratory experiments and the forms were evaluated by means of the method of paired comparison respectively.

Preliminary Experiment

This experiments were conducted to investigate the characteristics of the driver's spatial orientation.

Method

Subjects were fourty nine students (27 male, 22 female, age range 20-24) in Keio University and they had the driving experiences of 1-6 years. They were required to draw the map around the route between the nearby station and Keio university on the circle paper in the experimental environment as shown in Figure 1. The subjects were asked to draw the station in the center of the circle paper and to draw the university in the position where subjects could draw easily.

 0-7803-1235-X/93/$3.00

The subjects were sat facing the real direction from the university to the station. They were also instructed to draw the map while they rotated it if needed. All subjects had good knowledge of the route between the station and the university. The performance of the subject was observed all the time of the experiment.

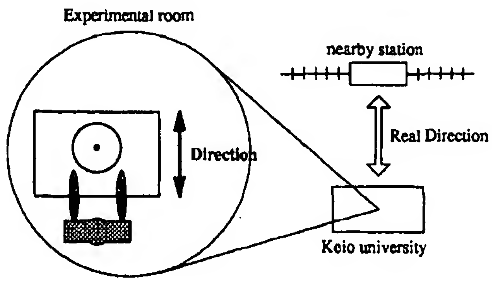

Figure 1: The image of experimental environment

Results

The subjects were divided into two categories by their performances. One was Fixing Group and Another was Rotating Group as follows.

- Fixing Group : The subjects who drew the map while fixing the circle paper as shown in Figure 2 (male 22, female 3).
- Rotating Group : The subjects who drew the map while rotating the circle paper to keep the direction of drawing in a constant direction as shown in Figure 3 (male 5, female 19).

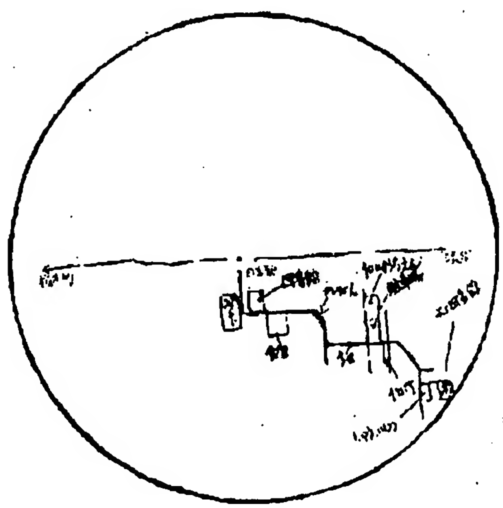

Figure 2: An example of the result in Fixing Group

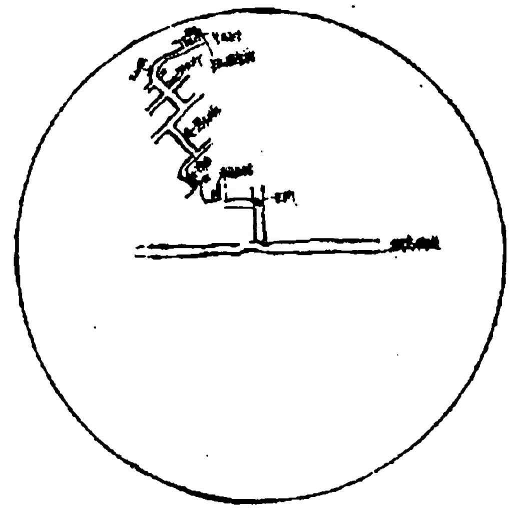

Figure 3: An example of the result in Rotating Group

Discussion

It was easy for the subjects to draw the map around the route since they go to the university every day. The results suggest that the subject's way of using the internal representation about the route was influenced by the characteristics of spatial orientation even if the subject has good knowledge of the route. It is important to investigate the relationship between driver's spatial orientation and the display forms of the digital map.

Field Experiments

This experiment investigated the driver's behaviors in the field course when using two kinds of the display forms in IVNS such as North-up and Heading-up.

Method

Subjects consisted of four subjects who belonged to the Fixing Group (4 male, 22-23 ages) and four subjects who belonged to the Rotating Group (1 male, 3 female, 22-24 ages) in the previous experiment. The subjects were asked to drive from the origin to the final destination through two middle points by selecting the shortest route. The distance of the shortest route determined from the map was about 10km. All subjects have never driven the area around the route. The subject's face was recorded to video tape by four small CCD cameras during their driving. The verbal data of the subject were also recorded to video tape by tiepin-type microphone. The eye movements and the verbal data were extracted from the recorded data after the experiment. The verbal data were analyzed by means of "thinking-aloud protocol method"[4] and subject's thinking and feeling when driving were extracted.

Results

Figure 4 and Figure 5 show the average and the percentage of eye fixation to the navigation display respectively only during driving.

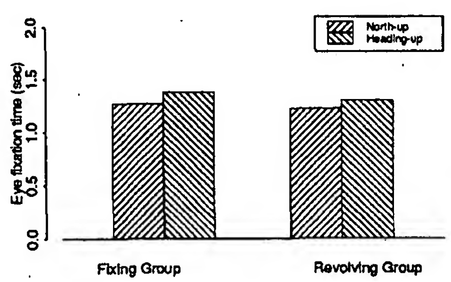

Figure 4: The average of eye fixation time for the navigation display

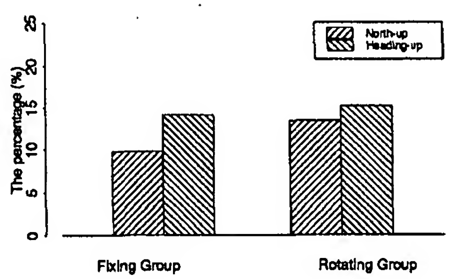

Figure 5: The percentage of eye fixation time for the navigation display

$$\text{The percentage of eye fixation time} = \frac{\text{The total eye fixation time}}{\text{The total driving time}} \times 100 \quad (1)$$

The percentage of eye fixation time was calculated by Equation (1). There was little difference in the average of the fixation time between the North-up and the Heading-up and between Fixing Group and Rotating Group judging from Figure 4. However, judging from Figure 5, the difference exists between Fixing Group and Rotating Group in terms of the percentage of fixation time. Based on the results of thinking-aloud protocol method and the questionnaire survey after the experiment, the driver's opinions when driving were categorized as follows.

The advantage points among display forms analyzed from verbal data ·

- North-up

  No rapid rotating of map in the CRT

  Easy to decide the route

  Easy to recognize the destination

- Heading-up

  Easy to adapt the map to the front view

  Easy to judge turning right or left

The disadvantage points of each display form analyzed from verbal data

- North-up

  Difficult to recognize the direction of movement

  Difficult to adapt the map to the front view

- Heading-up

  Being puzzled

  Difficult for the driver to correspond his memorized map and the map in CRT

  Difficult to recognize the destination

  Difficult to recognize that turnings have completed at intersections

About North-up form, Fixing Group pointed out the many advantages while Rotating Group pointed out the disadvantages.

Discussion

There was the difference between Fixing Group and Rotating Group in terms of the percentage of eye fixation time. Although there was little difference in the total distance which the subjects ran, there was slight difference in the frequencies of the eye fixation to the navigation display between North-up and Heading-up. The frequency of the eye fixation in North-up was smaller than the one in Heading-up. Judging from the results of verbal protocol analysis, the subjects tend to forget the map in their memories when the rotating angle in Heading-up was large. It is important to investigate the relationship between the driver's performance and the rotating angle in Heading-up form.

Laboratory Experiment

This experiment investigated the driver's characteristics for the rotating angle of the map in Heading-up form.

Apparatus

In this experiment, the driving simulator which consist of navigation display, display for driving view, steering-wheel, accelerator and brake was designed. Several rotating angles of the map in the navigation display can be selected.

Method

Subjects were four persons who belonged to the Fixing Group (4 males, 22-23 ages) and four persons who belonged to the Rotating Group (2 male, 2 female 22-24 ages). They had the 3-5 years driving experiences. Four types of display form in IVNS were used in the experiment. They were one North-up form and three Heading-up forms which had rotating angles 30°, 45°, 90° respectively. The driver's eye movements was measured and evaluated. The subjective rating was also measured after the experiment.

Result

The results of the eye movements are shown in Figure 6 and Figure 7. The differences among the 4 forms are not clearly indicated. The results of the subjective rating were

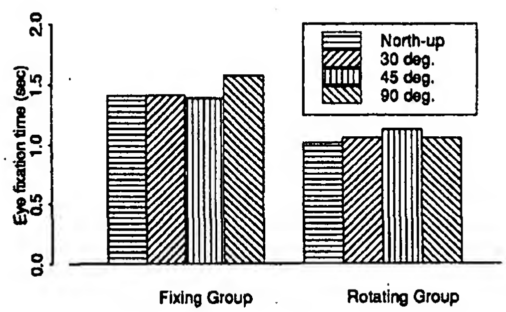

Figure 6: The relationship between the display forms and the average of the eye fixation time

different among the four display forms in IVNS. The items appeared in subjective rating such as "Feeling confidence" or "Easy to recognize the destination" indicated that North-up form was better for Fixing Group, Heading-up form was better for Rotating Group. The items on "Easy to decide the route" show that North-up form was better for Fixing Group. The items on "Easy to decide turning right or left in the crossing" showed that Heading-up form was better for Rotating Group. Regarding the Heading-up form, the angles such as 30° or 45° was better than 90°. Especially 45 degrees was the best as far as our experiments are concerned.

Conclusion

The differences of the results in eye movement were not clearly observed. It can be interpretated that the laboratory environment was very different from the fields environment. Judging from the results of the subjective ratings, two important points can be pointed out as in the following.

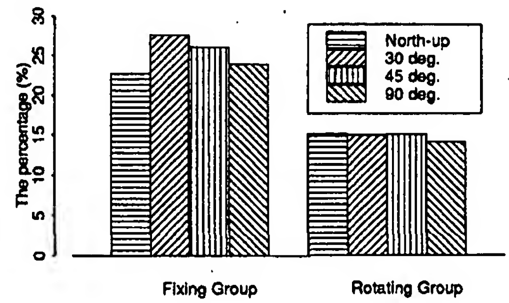

Figure 7: The relationship between the display forms and the percentage of the eye fixation time

- The display form which should be adapted to the driver's characteristics of the spatial orientation was better.
- When using Heading-up type display, the rotating angle of the map needs a special care. In our experiments, Heading-up type display which rotates at 45 degrees had best performance.

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